

Army Acoustics Needs
**DARPA Air-Coupled Acoustic
Micro Sensors Workshop**

by

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- To research, explore, and develop innovative and state of the art signal processing techniques in acoustics and other passive sensor technologies
- To apply these techniques to perform detection and classification of ground troops, ground vehicles, airborne vehicles, artillery and sniper
- To transition real-time and robust algorithms to on-going Army acoustic programs

**Army Battlefield Acoustics Research
conducted at ARL, ARDEC and CRREL**



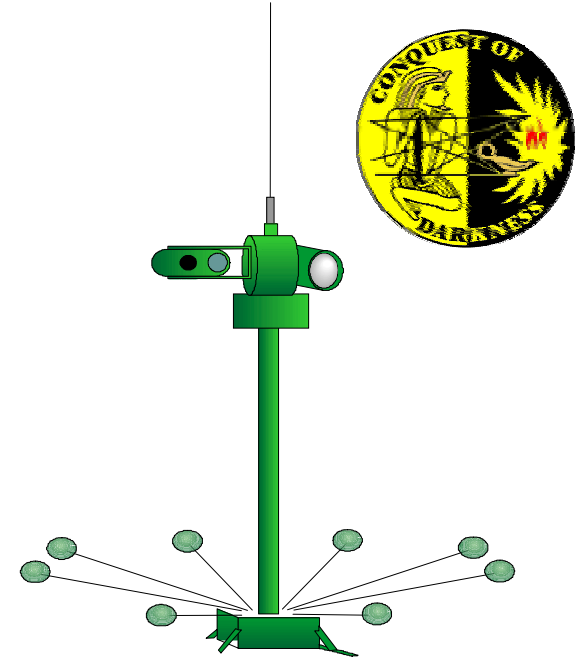
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Acoustic Advantages



BATTLEFIELD ACOUSTICS

- Attractive technology for the Army
 - Passive
 - Non-line of sight (NLOS)
 - Low cost
 - Small and rugged
 - Provides 360° coverage
 - Target signatures are hard to suppress
- Capability includes target detection, bearing estimation, tracking, localization, classification and ID
 - Provides wake-up and cueing of optical sensors



Real-time capability due to advances in CPU and DSP technology



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Army Applications



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Detection, tracking and classification

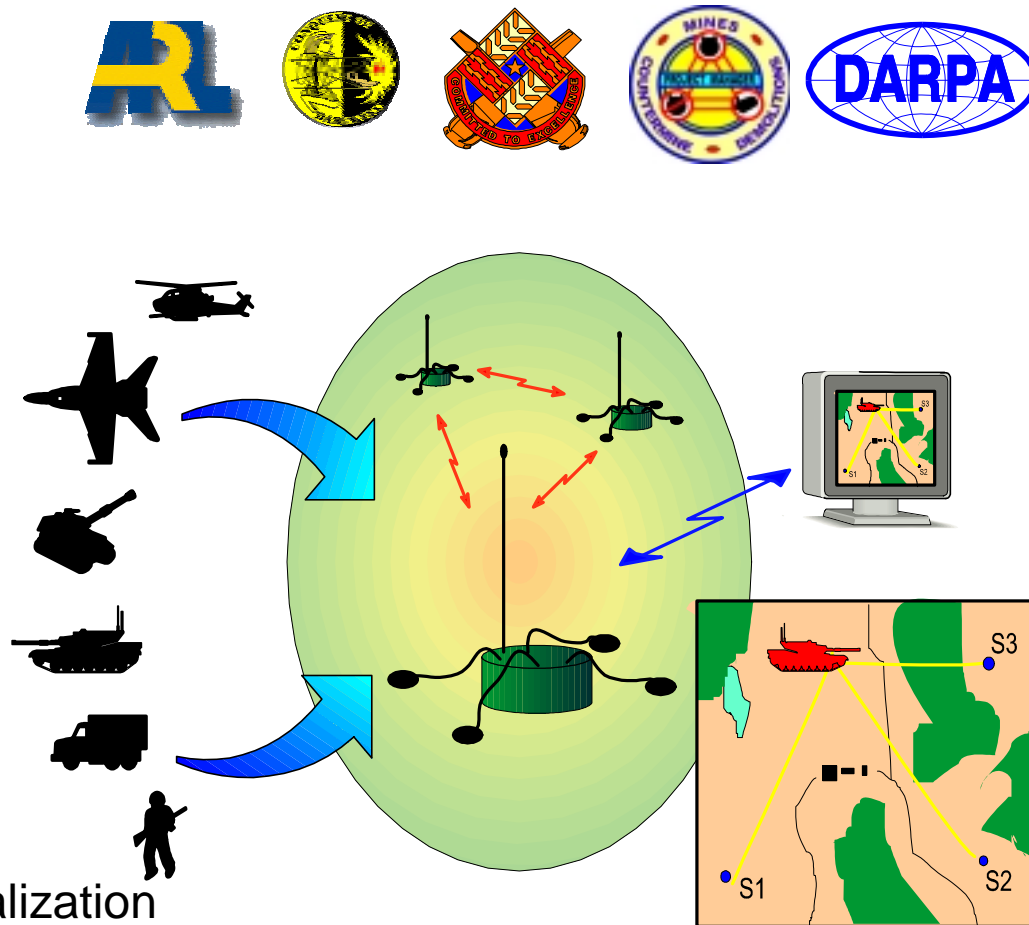
- Ground vehicles
- Troop movements
- Fixed and rotary wing aircraft's

Surveillance and monitoring

- 360° field of view coverage
- Excellent “wake-up” and cueing sensor
- Tactical decision aid

Other Applications

- Infrasonic detection and localization
- Physiological monitoring of soldiers
- Detection and localization of gun fire (e.g., sniper), artillery / mortar fire, rocket launch, etc.



- Noise Cancellation:
 - Need to cancel out platform noise for acoustic sensors mounted onto idle or moving vehicles to allow detection and identification of surrounding targets.
 - Need to cancel out wind / flow noise from acoustic sensors positioned on the ground or on top moving vehicles.
- Lack of data from acoustic sensors mounted on top vehicles.
- Lack of research conducted in this topic





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Current Army Needs



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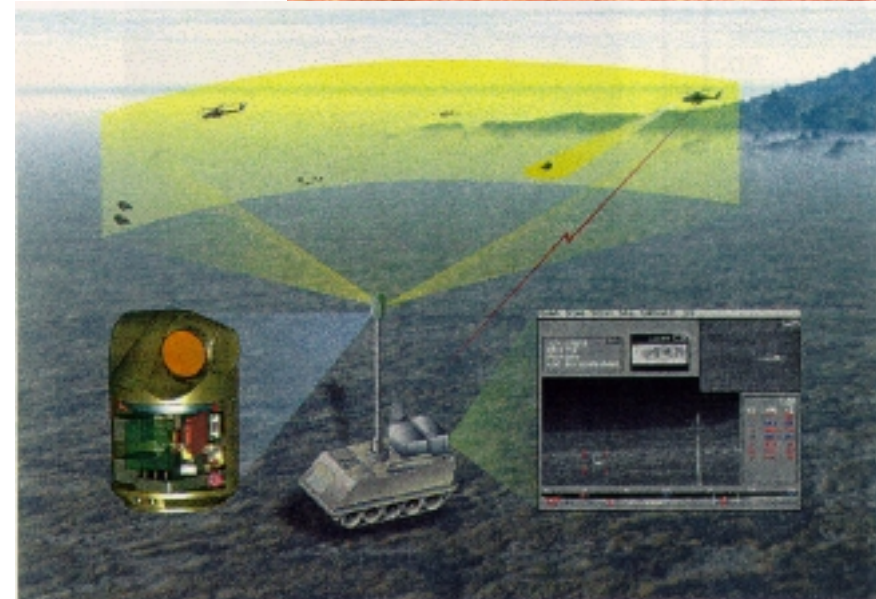
- **Research Issues**

- Noise cancellation / Platform and Wind
- Multi Target Recognition
- Sensor fusion
- MEMS Acoustic / Seismic



- **Programs**

- MFS3 / FSV
- DEMO III Robotics
- Sniper Detection Systems
- Unattended Ground Sensors





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R&D Transition / Programs



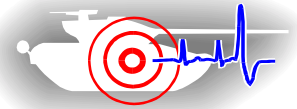
BATTLEFIELD ACOUSTICS

- **Transition R&D into future Army programs in support of RDECs and Battle Labs**
 - Infrasonic research
 - Modeling of acoustic sensors
 - Anti-Personnel Landmine Alternatives (APLA)
 - Warrior Extended Battlespace Sensors (WEBS)



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Infrasonic Research

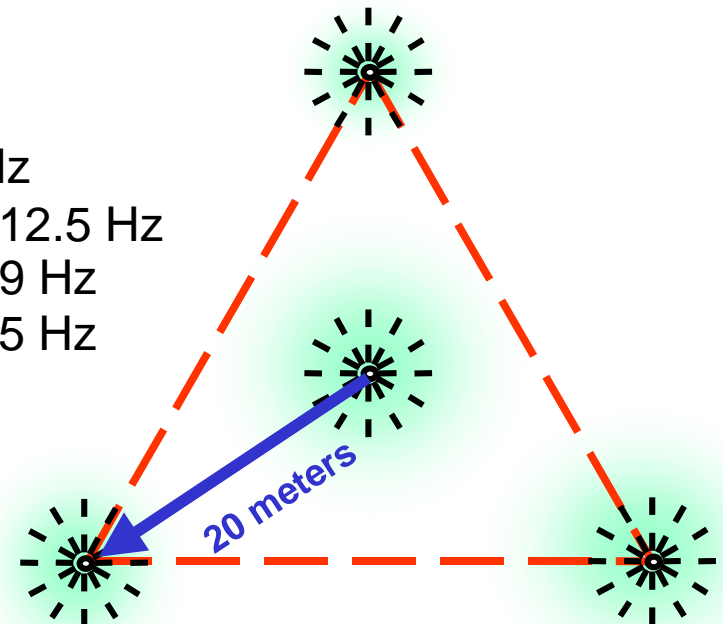


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- **Objective:** to develop state-of-the art infrasonic sensors and signal processing algorithms to detect, classify, localize of impulsive signals below 20 Hz
- **Army applications**
 - Artillery and mortar firings
 - Missile and rocket launches
- **Other infrasonic signals of interest:**

– Nuclear tests:	0.02 Hz - 4 Hz
– Earthquakes:	0.125 mHz - 12.5 Hz
– Volcanoes, meteors:	23 mHz - 0.29 Hz
– Winds, tornadoes, etc.:	10mHz - 0.125 Hz

- Six 20 ft. porous hose lengths at each sensor
- Met sensors located with central microphone.



Los Alamos





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Infrasonic Detection

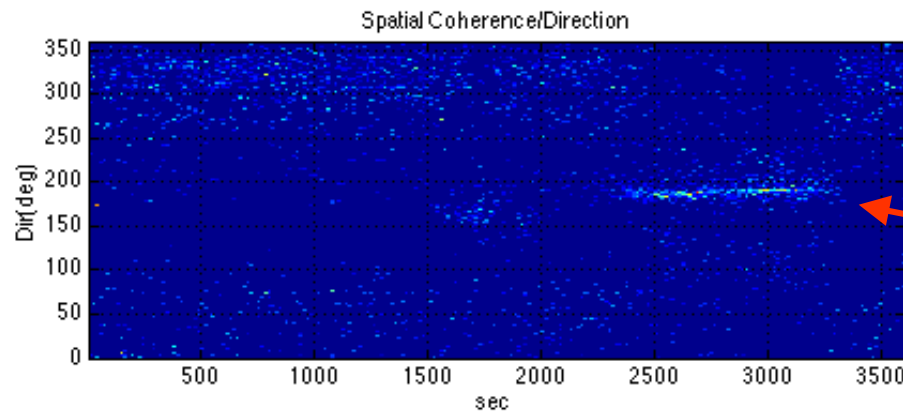
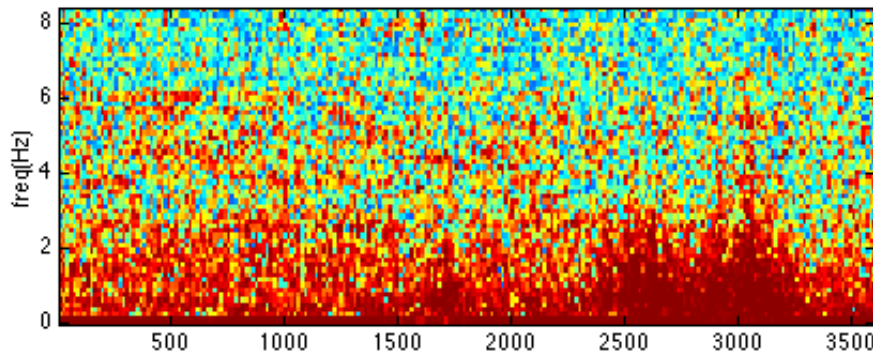


BATTLEFIELD ACOUSTICS



**Space Shuttle Launch
4 Dec 98
From Blossom Point, MD**

Date: 12/4/98 Time: 3:54:28



Direction of arrival



Modeling of Acoustic Sensors



Objective:

- Database: to centralize acoustic data archives from various programs & organizations, to expedite data access and to ease data maintenance
- ATR Lab: to expedite algorithm development & performance evaluation against various battlefield conditions

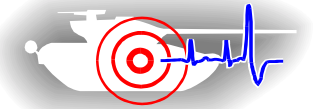
The screenshot displays a web-based application interface for an acoustic database. The interface is divided into several sections:

- Navigation Tabs:** Files, Targets (selected), Sensors, Data Collections, SQL Commands.
- Select table:** A dropdown menu showing 'Ground_Info' and an 'Open Table' button.
- Form Fields:** A series of input fields for target information:
 - Target_ID: 5
 - Target: 2.5-Ton Truck
 - Class: light wheeled
 - Country: USA
 - Weight (kg): 5900
 - Length (m): 6.7
 - Width (m): 2.4
 - Height (m): 2.92
 - Engine: 6-cylinder in-line multi-fuel diesel, 140 hp @ 2600 rpm
 - Transmission: manual gearbox with 5 forward and 1 reverse gears
 - Max_Speed (mph): 21.6
 - Crew: 1+2
 - Picture: 2-5ton_1.gif; 2-5ton_2.gif
 - Signature: y
- Move record:** Buttons for First, Prev, Next, Last.
- Sort by:** A dropdown menu set to 'Target_ID' and a 'Sort' button.
- Edit:** Buttons for Add, Add/C, Modify, Update, Clear, and Delete.
- Search by:** A dropdown menu set to 'Target_ID', an 'Enter text:' input field, and a 'Go' button.
- Print Record:** A button to print the current record.
- Image:** A small image of a 2.5-ton truck with the caption '2.5 TON TRUCK' below it.
- Footer:** A status bar showing 'acoustic database' and '# Records: 6'.

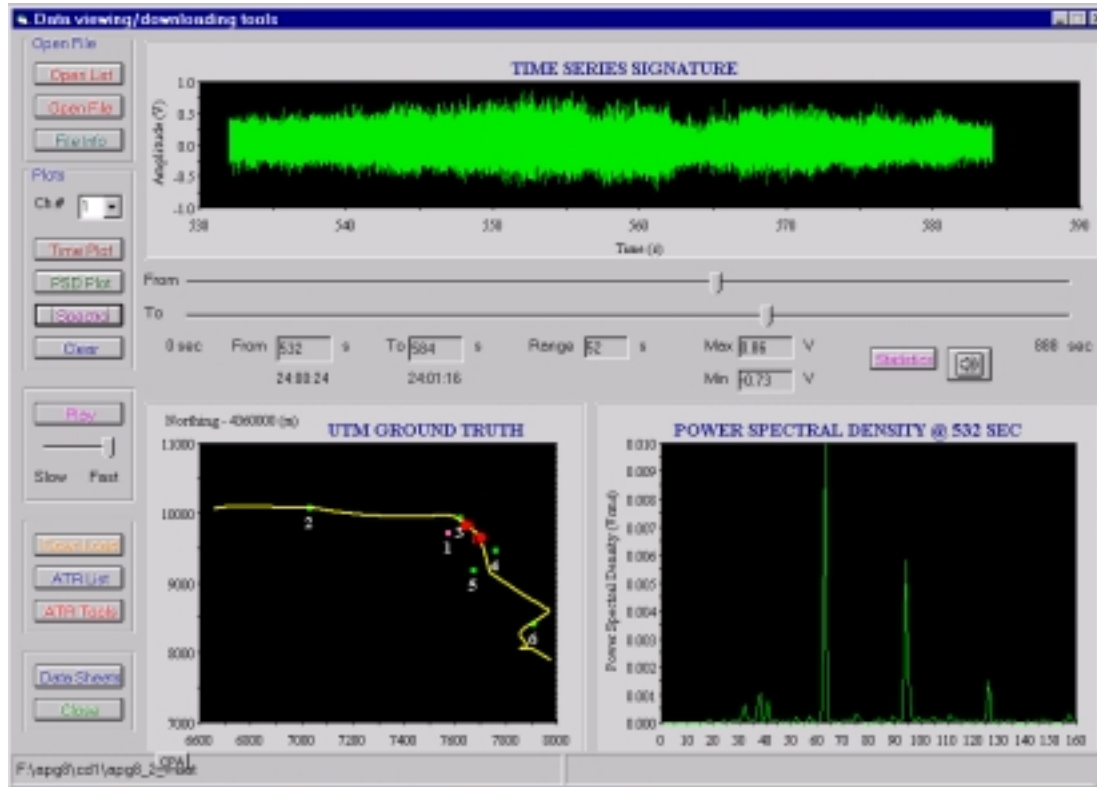


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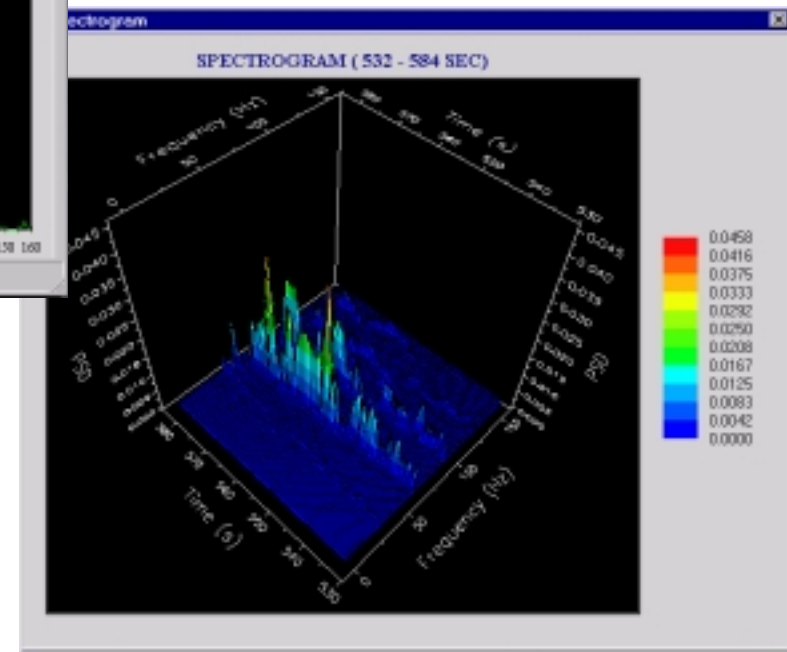
Data Management and Processing



BATTLEFIELD ACOUSTICS



Large selection of trucks, tanks and helicopter signatures collected at different environment and time of year



Server - Client environment will allow user to access data on-line.

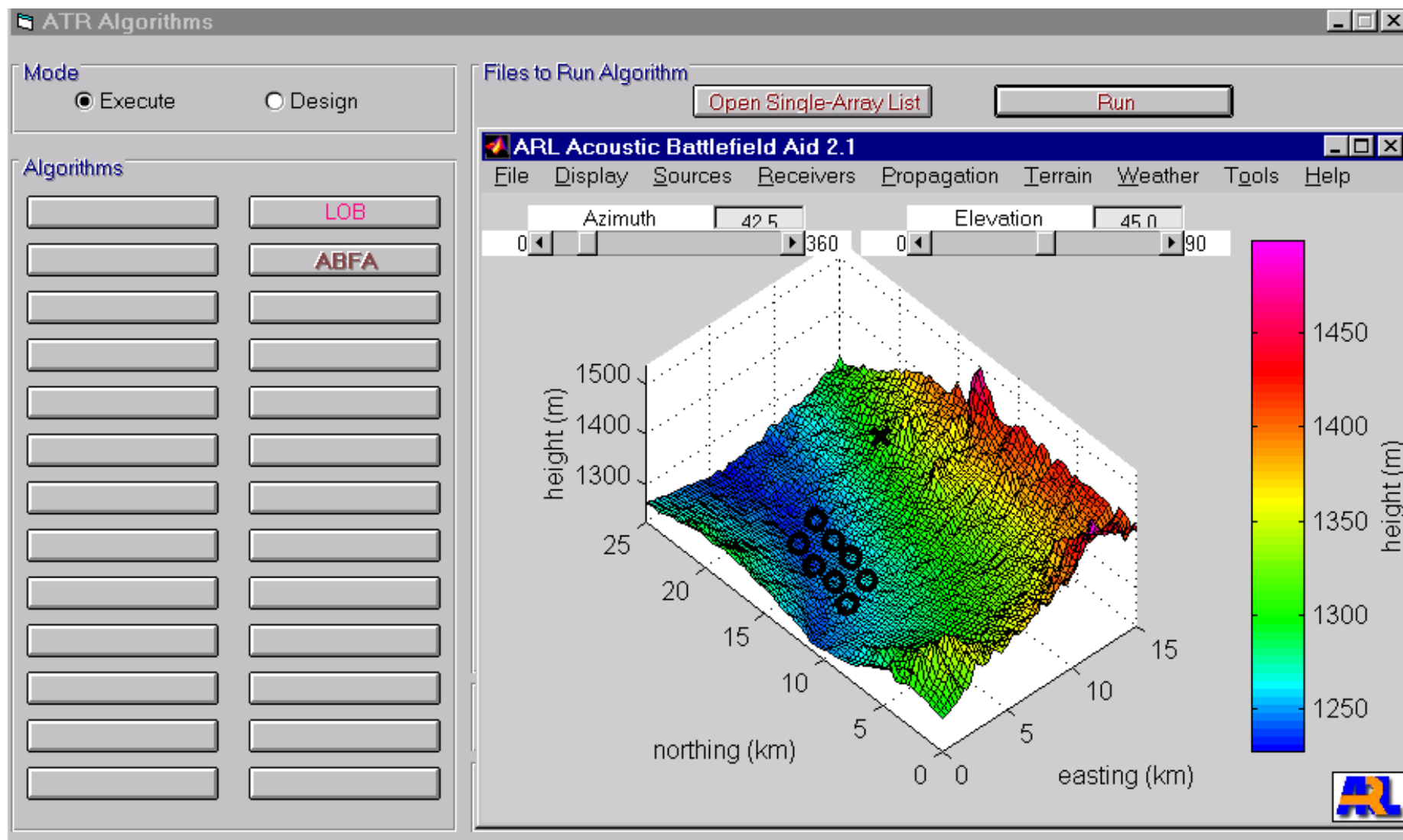


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ATR Lab and Decision Aid



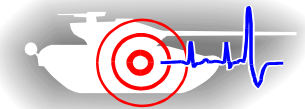
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Anti Personnel Landmine Alternative (APLA)



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- **Current Progress**

- Experimenting with existing small, sensor systems capable of detecting personnel using acoustic / seismic / magnetic sensors.



- **FY00**

- Research and evaluate personnel detection algorithms with low false alarm.
- Use fusion techniques between suite of orthogonal sensors to enhance detection and recognition



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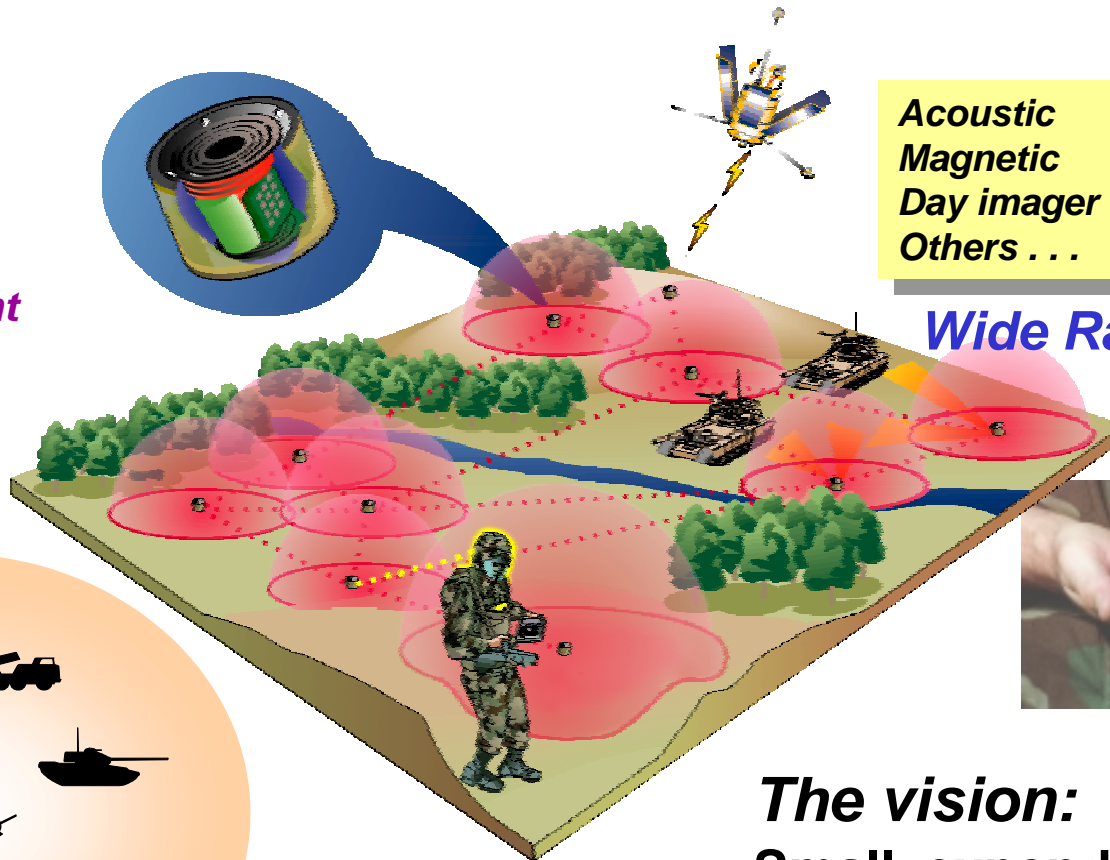
Warrior Extended Battlespace Sensors (WEBS)



BATTLEFIELD ACOUSTICS

*A network of sensor nodes using multiple types
of sensors can accurately locate and identify battlefield targets*

*Small
Passive
Real Time
Very Low Cost
Non-line of sight
360° Coverage*



Acoustic
Magnetic
Day imager
Others . . .

Seismic
Low cost IR
Passive RF

Wide Range of Sensors



The vision:
Small, expendable sensors

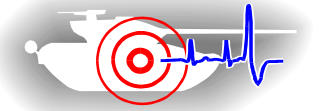


Wide Range of targets

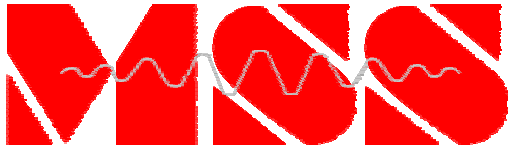


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Upcoming Symposia



BATTLEFIELD ACOUSTICS



Military Sensing Symposia

Yearly event, established to share battlefield acoustic research knowledge between government, industry and universities.

Battlefield Acoustic Symposium Sept 13 - 15, 1999
Johns Hopkins University, MD, Security Clearances Required

National Symposium Nov 16 - 19, 1999
SPAWAR Systems Center, SC

SPIE - *The International Society for Optical Engineering*

Sensor Technology for the Urban Battlefield
Orlando, FL April 24 - 28, 2000